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GENERAL NOTES.

Photography of the Aurora.—An account is given in *Nature* for August 7th of the excellent results which have been secured by Professor CARL STÖRMER in auroral photography. The data secured by the expedition will form a very valuable extension to the important results secured photographically by Dr. STÖRMER in 1910 at the same station. From a discussion of the negatives secured at that time the average height of the auroral formations was found to be about seventy-five miles, though some formations were observed as high as two hundred miles. From February 28th to April 1st, 636 pairs of simultaneous photographs of the aurora were made at the two stations selected, Bossekop and Store Korsnes, in northern Norway, the latter station being nearly seventeen miles north of the former. Of these photographs, 450 pairs are said to be very satisfactory, and will furnish material to compute with a large degree of accuracy the form, position, and altitude of all the principal kinds of aurora borealis. At the same time exposures were made with a prismatic camera, showing superposed images of the aurora corresponding to the different spectral lines. A kinematograph was also successfully employed to obtain successive photographs showing the rapid changes which take place in form of the auroral streamers.

Dr. KEIVIN BURNS has received an appointment in the Bureau of Standards, Washington, D. C. Dr. BURNS was for several years assistant in the Lick Observatory, and for two years past has held the Martin Kellogg Fellowship. He has spent the major portion of the two years in carrying out several important pieces of research work in spectroscopy in the physical laboratories at Bonn under the direction of Professor KAYSER, and at Marseilles under Professors FABRY and BUISSON.

Dr. SEBASTIAN ALBRECHT, formerly assistant astronomer at Lick Observatory and first astronomer at Córdoba, Argentina, has been appointed astronomer at the Dudley Observatory, Albany, N. Y.

The Minister of Public Instruction of Argentina has authorized the preparation of an expedition from the National Observatory at Córdoba, in charge of Director PERRINE, to observe the Russian total solar eclipse of August 20-21, 1914. The expedition will be composed of three members of the Córdoba staff, with an extensive equipment of instruments, and will be located in southern Russia, not far from the Black Sea. It is expected that the expedition will be joined by astronomers from the Berlin, Potsdam, and Königsberg observatories.

*An Arithmetical Curiosity.*¹ — What is the largest number that can be expressed by three digits? The answer is, of course, 9^9 ; it is a number of inconceivable and appalling magnitude, compared with which the huge numbers that we meet in sidereal astronomy fade into absolute insignificance: 9^9 is 729^3 , which is easily found to be 387,420,489. We have to multiply the logarithm of 9 by this figure in order to obtain the logarithm of 9^9 . The number represented by this arrangement of three digits will contain 369,693,100 digits. The first twenty-eight of these figures will be 428,124,773,175,747,048,036,987,115,9, and the last three figures of the number will be 289. A knowledge of only thirty-one figures out of over three hundred million may seem trifling, but in reality the error involved in taking all the remaining figures as zeros is only one part in a thousand quadrillions. If the number were printed with sixteen figures to the inch, it would extend over 364.7 miles; it would fill thirty-three large volumes of 800 pages and 14,000 figures to the page. There are more than twice as many digits in the number as there are letters in the whole of the *Encyclopædia Britannica*. . . . What is the smallest thing we have yet thought of? Probably an electron is about the right answer. Call it A. And what is the largest? Dr. CROMMELIN takes a million light-years as the largest distance of a star yet mentioned seriously. Describe a platinum sphere of this radius, and find the number of electrons in it; there will be ninety-one figures in the result. Take this huge sphere B as an electron and find a new platinum sphere C, which shall

¹ Abridged from Dr. CROMMELIN's paper of this title in the *Journal of the British Astronomical Association* for May, 1913, and from *The Observatory* for July, 1913.

be in the same relation to it as that just sketched (B to A). Take C as an electron and find D, with the same ratio. Take D as an electron and find E; take E as an electron and find F. E will contain fewer, and F more electrons, than this enormous number.

Longitude Determinations by Wireless Telegraphy.—According to a circular issued by Captain J. L. JAYNE, Superintendent of the U. S. Naval Observatory, there is to be conducted, between October 1, 1913, and April 15, 1914, "a determination of the difference of longitude between the U. S. Naval Observatory in Washington and the Paris Observatory in France, utilizing radio signals from the Naval Radio Station at Arlington and from the Eiffel Tower Station in Paris."

It is planned that the astronomical work shall be done with instruments of high precision, every precaution being taken to determine the clock corrections "with extremely small accidental and systematic errors, either instrumental or personal."

The invitation is extended to any observatory within radio-receiving distance from Washington to determine its longitude relatively to that of the Naval Observatory, by installing a radio-receiving apparatus.

A New Reflecting Telescope for Canada.—The powers of astronomical mirrors have developed so extensively in the last decade that many new reflectors have been and are being constructed. The greatest success of a decade ago was attained with the Crossley reflector and the most recent is that of the Mount Wilson 60-inch. The mammoth mirror of the present day is the 100-inch to be mounted soon on Mount Wilson. Reflectors have been set up at Yerkes, Harvard College, Allegheny, Detroit, and Lowell observatories in the United States, and at Arequipa, Santiago de Chile, and Helwan, Egypt, and new ones are being designed for the University of Illinois and the Dominion of Canada. That for Canada will be as large or larger than the largest now of demonstrated success—namely, 60 or 70 inches.

It is the intention of the Dominion Government to spend \$50,000 for the new instrument and to locate it at an altitude of

a few thousand feet, probably in or west of the Canadian Rockies. Bids for construction have been requested from builders in Great Britain and the United States. Specifications have been laid down by Dr. W. F. KING, chief astronomer, and appear in the *Journal of the Royal Astronomical Society of Canada*, **7**, 216. Many of these specifications will be of interest to those who are interested in astronomical work. Dr. PLASKETT, of the Dominion Observatory, has visited California Observatories to inspect their reflectors and Mr. HARPER has been searching for a site in Western Canada, investigating in particular the "seeing." In this connection, he recently visited Mount Hamilton.

The principal work of this telescope will be that of spectroscopic observation for which the telescope will be used in Cassegrainian form, like the D. O. Mills reflector at Santiago de Chile, the spectrograph being attached below the primary mirror. The telescope will also be used, like the Crossley and 60-inch reflectors, for direct photography at the primary focus, or at the Newtonian focus at the side of the upper end of the tube, or at the Cassegrainian focus below the mirror.

According to the specifications, the mirrors shall be cast of hard crown glass, free from large defects and strains and thoroughly annealed. The diameter of the large mirror is to be five or six feet, and that of the small mirror about twenty inches. The thickness of the glass for the former is to be at least eight inches. The focal length of the primary mirror will be twenty-five or thirty feet and that of the Cassegrainian combination ninety or more feet. The optical surfaces shall be of the highest quality and figuring, and shall be tested by the Foucault or knife-edge method. The tests shall not show variations of more than a hundredth of an inch from the theoretically computed values of the radii of curvature of different zones. The artificial star used in the testing shall be formed by the condensation of the light of a powerful electric arc on a small hole not greater than two thousandths of an inch in diameter. Constant temperature shall be maintained during the testing. The Hartmann test shall be provided for if required. The tests shall finally be performed and the results approved by the representative of the government. Flat mirrors shall be provided for the Newtonian form of the

telescope. Eye-pieces shall be provided for the Newtonian and Cassegrainian focus. Guiding eye-pieces shall be provided with the double slide plate-holder for direct photography. Two four-inch finders shall be fixed to the lower end of the tube. One seven-inch finder of long focus shall be provided.

The mounting is to consist of a long polar axis supported on separate columns and of a declination axis located between the bearings. The tube will be mounted on the declination axis as close as possible to the polar axis. This form of mounting is like that of the Melbourne, the Paris, and the Ann Arbor reflectors. The supporting piers shall be of cast iron, provided with the usual means of adjustment in altitude and azimuth. All bearings shall be roller bearings, running in bearing sleeves of hard steel ground with greatest accuracy. Hand wheels for quick motion shall be provided on the piers and the setting circles shall be arranged so as to be conveniently read from these hand wheels. The right-ascension circle shall be given motion at the sidereal rate so that the setting may be made directly from right ascension. Quick motion in declination shall also be given by an electric motor. Slow motions in right ascension and declination shall be effected by means of electric motors, controlled by switches which may be held in the hand of the observer either at the upper or the lower end of the tube to enable the fine setting and guiding to be done at the finders and guiding eye-pieces.

The telescope tube shall consist of a closed central section of cast iron and an upper section of skeleton construction, which shall be as light as possible consistent with rigidity. The flexure shall not exceed one eighth of an inch when the tube is horizontal. The upper end of the tube shall be so designed as to allow convenient change from one form of telescope to another—that is, from Cassegrainian to Newtonian or to prime focus observation. The secondary mirror, which will be nearly twenty-three feet above the primary mirror, shall be held tightly without constraint in its cell, but easily movable for adjustment in collimation and for focusing. The focusing shall be effected by rods and gears extending to the lower end of the tube. The upper end of the tube must rotate for proper position in guiding. The mirror cell, which shall be of cast iron, containing a system of counter-weights to support the

mirror, will be attached beneath the central section. A ring three feet in diameter will be cast on to the bottom of the cell, which will allow for attaching and rotating the spectrograph. The frame holding the spectrograph may extend as much as eight feet below the mirror cell, but the lower end of the spectrograph frame shall not exceed one-half of the diameter of the upper end. The driving clock shall have gears, finely ground and without any periodic error. The driving worm and wheel shall be cut as truly as possible and finished by grinding. A system of wiring for illumination of circles, guiding eye-pieces, and for quick- and slow-motion motors and wires for the spectrographic apparatus shall be designed and installed without bearing rings or brushes.

For the purpose of transportation, no piece of the telescope shall weigh more than five tons. The telescope shall not be considered completed until it operates to the satisfaction of the representative of the government.

This instrument should prove to be of great capacity in performing its contemplated work.

G. F. P.